

REMARKS

The Examiner will note that claims 1 and 9 have been amended. Applicants amended claim 1 to include that the mesoporous aluminophosphate is amorphous. Support for this amendment may be found in the last sentence at the bottom of page 4 (definition of "mesoporous" and in the first line at the top of page 6 (formation of a homogeneous gel). These properties are characteristic of amorphous materials, not crystalline materials. As shown in the "Atlas of Zeolite Structure Types", pages 8-11, copy attached, crystalline aluminophosphates designated as ALPO_4 have pore diameters in the range less than 8.7 Angstroms, i.e., the largest aluminophosphate shown, ALPO_4 -8 (14 ring structure) has a pore diameter of 7.9 x 8.7. This in contrast to the 30 - 100 Angstrom definition of "mesoporous" as noted above. Applicants will submit an affidavit in support of the amorphous character of their aluminophosphates if requested by the Examiner. Additionally, applicants have amended claim 9 to correct the term "sulfur" to "sulfur". Applicants request that these amendments be entered to put these claims in better form for allowance. Additionally, these amendments do not bring up new issues.

Rejection under 35 U.S.C. § 103(a)

The Examiner has rejected claims 1-9 under 35 U.S.C. § 103(a) as being unpatentable over Absil et al. (5,456,821) in view of Pine (3,904,550) and Kearby (3,271,299). The Examiner stated that the reference of Absil et al. disclose a catalytic cracking process involving the use of a large pore aluminophosphate composition with pore openings greater than 7 angstroms. The Examiner also stated that the catalyst may comprise zeolite-Y and the catalytic conversion is suitable for the production of gasoline from a heavy feed such as gas oil. Applicants point out that col.7, lines 11-18 cited by the Examiner relate to a crystalline molecular sieve such as AlPO_4 -5. In contrast, applicants' catalyst composition is amorphous. Applicants also note that Absil et al. relate to a catalytic cracking process involving, in addition to a large pore catalyst, an additive catalyst formulated by a special method. This special method generally involves treating clay or a zeolite (specifically a medium pore zeolite such as ZSM-5) with a phosphorous compound, usually phosphoric acid. The clay or zeolite is then added to the resulting slurry. It is only at this point that alumina is added. The alumina is specifically in the form of pseudoboehmite alumina, which has been peptized with formic acid. At this stage, the clay or zeolite has consumed most of the previously added phosphorous by reaction. Thus, the

phosphorus is unavailable to react with the alumina to form anything like the mesoporous aluminophosphate of the present invention. The aluminophosphate of the present invention is an amorphous discrete material formed separately from the ultimate cracking catalyst composition and is made by precipitation from an aqueous solution of three (or more) elements, which is in contrast to Absil et al. where no third element is added to allow the formation of the crystalline aluminophosphate. Accordingly, one skilled in the art would not have been led to employ an aluminophosphate composition of the present invention from Absil et al.

The deficiencies in Absil et al. are not overcome by combining it with any of the secondary references. As noted by the Examiner, the Pine reference discloses that zirconium, cobalt, zinc, and vanadium are known to promote aluminum phosphates in cracking reaction. However, as shown in Ex. 4 of Pine, the metal is added to the extrudate. This is in contrast to applicants' invention in which the metal is part of the support aluminophosphate (see Ex. 1). Applicants note that the aluminophosphates of Pine do not have similar properties to the aluminophosphates of the present invention, such as the surface area, pore size, and pore diameter. Another contrast between Pine and the present invention is that the present invention teaches that the aluminophosphate is formed separately from the ultimate cracking catalyst composition and are not a part of the original preparation. Moreover, there is no disclosure in Pine of the use of alumina-aluminum phosphates for better bottoms cracking or for reduction of gasoline sulfur as in the present invention.

Furthermore, the deficiencies in Absil et al. are not overcome by combining it with Kearby. The Examiner states that Kearby discloses aluminophosphate materials with surface areas of 200-600 m²/g and pore diameters of 72 angstroms. The aluminophosphate of the present invention is an amorphous discrete material formed separately from the ultimate cracking catalyst composition and is made by precipitation from an aqueous solution of three (or more) elements, which is in contrast to Kearby where no third element is added to allow the formation of the aluminophosphate. The Kearby materials are suitable for catalytic cracking, but there is no teaching that they are useful in bottoms cracking or reducing sulfur in gasoline.

The combination of Absil et al. and Pine does not teach or suggest applicants' invention. First, the aluminophosphate catalyst of Absil et al. is crystalline while applicants' aluminophosphate is amorphous. Second, Pine teaches adding metal to the already formed catalyst, not modifying the aluminophosphate as is the case in the present process.

The selection of the surface area or pore volume for the aluminophosphate catalyst of Kearby would likewise not teach or suggest amended claim 1 as applicants' claim an amorphous, not a crystalline material as taught by Absil et al.

Additionally, the Examiner has rejected claims 1-9 under 35 U.S.C. 103(a) as being unpatentable over Kowalski et al. (5,888,378) in view of Pine (3,904,550) and Kearby (3,271,299). The Examiner stated that Kowalski et al. disclose a process for catalytic cracking of a hydrocarbon employing a large pore phosphorous containing zeolite (ALPO) and/or zeolite-Y. The large pore zeolite has a pore size of greater than 7 angstroms and that the process is suitable for producing gasoline from heavier hydrocarbons. Applicants wish to point out that Kowalski et al. do not disclose "a large pore phosphorus containing zeolite (ALPO) and/or zeolite Y." The zeolite is in fact ZSM-5, which is an aluminosilicate, not an ALPO, but an AlPO_4 , which is only mentioned as a possible constituent of the catalyst. Applicants' catalyst composition is amorphous and not the crystalline sieve of Kowalski et al. Furthermore, the present invention teaches that the aluminophosphate is formed separately from the ultimate cracking catalyst composition and are not a part of the original preparation.

The deficiencies in Kowalski et al. are not overcome by combining it with any of the secondary references for the same reasons stated above.

In view of the foregoing comments and amendments, applicants respectfully request that the Examiner withdraws the rejections under 35 U.S.C. § 103 and passes this application to allowance.

If the Examiner believes a telephone conference would expedite prosecution, the Examiner is invited to contact Gerard J. Hughes, Reg. No. 41,855, at (225) 977-4942.

Respectfully submitted,

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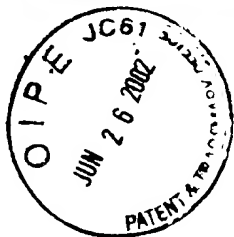
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VERSION WITH MARKINGS TO SHOW CHANGE:

1. A process for catalytic cracking of a hydrocarbon feedstock comprising contacting the feedstock with a catalyst composition comprising an amorphous mesoporous aluminophosphate material which comprises a solid aluminophosphate composition modified with at least one element selected from zirconium, cerium, lanthanum, manganese, cobalt, zinc, and vanadium, wherein the mesoporous aluminophosphate material has a specific surface of at least 100 m²/g, an average pore diameter less than or equal to 100Å, a pore size distribution such that at least 50% of the pores have a pore diameter less than 100Å.

9. The process of claim 1 wherein the hydrocarbon feedstock contains sulfur and the process produces a gasoline boiling range product having a lower [sulfer] sulfur content than the feedstock.



AKCg

ATLAS OF ZEOLITE STRUCTURE TYPES

W.M. Meier, D.H. Olson and Ch. Baerlocher

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by

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This TD is the same for all T atoms in a structure. It is included in the appendix for all structure types together with the TD_{10} that was listed in the previous ATLAS. There is a simple relationship between TD and TD_{10} : $TD_{10} \sim TD * 1155$. The correlation factor between the exact topological density TD and the framework density FD is 0.82.

CHANNELS

A shorthand notation has been adopted for the description of the channels in the various frameworks. Each system of equivalent channels has been characterized by

- the channel direction (relative to the axes of the type structure),
- the number of either T- or O-atoms (in bold type) forming the rings controlling diffusion through the channels, and
- the crystallographic free diameters of the channels in angstrom units.

The number of asterisks in the notation indicates whether the channel system is one-, two- or three-dimensional. Only those apertures which are more open than regular six-rings have been included. In most cases, the smaller openings simply form windows (rather than channels) connecting larger cavities. Interconnecting channel systems are separated by a double arrow (\leftrightarrow). A vertical bar (|) means that there is no direct access from one channel system to the other. The examples from Table 1 have been selected to illustrate the use of these notations. Cancrinite is characterized by a 1-dimensional system of channels parallel to [001] or *c* with circular 12-ring apertures. In offretite the main channels are similar but they are interconnected at right angles by a 2-dimensional system of 8-ring channels, and thus form a 3-dimensional channel system. The channel system in mordenite is essentially 2-dimensional with somewhat elliptical 12-ring apertures. The 8-ring limiting diffusion in the [010] direction is an example of a highly puckered aperture. Zeolite rho is an example of a framework type containing two non-interconnecting 3-dimensional channel systems which are displaced with respect to one another ($\langle 100 \rangle$ means there are channels parallel to all crystallographically equivalent axes of the cubic structure, i.e., along *x*, *y* and *z*). In gismondine, the channels parallel to [100] together with those parallel to [010] give rise to a 3-dimensional channel system which can be pictured as an array of partially overlapping tubes.

Table 2 Channel dimensions

14-, 18-, & 20-Ring Structures

-CLO	Cloverite	$\langle 100 \rangle$ 20 13.2 x 4.0*** $\langle 100 \rangle$ 8 3.8***
VFI	VPI-5	[001] 18 12.1*
AET	AlPO ₄ -8	[001] 14 7.9 x 8.7*

12-Ring Structures

AFI	AlPO ₄ -5	[001] 12 7.3*
AFR	SAPO-40	[100] 12 6.7 x 6.9* \leftrightarrow [010] 8 3.7*
AFS	MAPSO-46	[001] 12 6.3* \leftrightarrow \perp [001] 8 4.0 x 4.0**
AFY	CoAPO-50	[001] 12 6.1* \leftrightarrow \perp [001] 8 4.0 x 4.3**
ATO	AlPO ₄ .31	[001] 12 5.4*
ATS	MAPO-36	[001] 12 6.5 x 7.5*
BEA	Beta	[001] 12 5.5 x 5.5 \leftrightarrow $\langle 100 \rangle$ 12 7.6 x 6.4**
BOG	Boggsite	[100] 12 7.0 x 7.0* \leftrightarrow [010] 10 5.2 x 5.8*
BPH	Beryllophosphate-H	[001] 12 6.2 x 6.7* \leftrightarrow \perp [001] 8 3.0 x 3.2**
CAN	Cancrinite	[001] 12 5.9*
CON	CIT-1	[001] 12 6.4 x 7.0* \leftrightarrow [100] 12 6.8* \leftrightarrow [010] 10 5.1 x 5.1*
DFO	DAF-1	{[001] 12 7.3 \leftrightarrow \perp [001] 8 3.4 x 5.6}*** \leftrightarrow {[001] 12 6.0 \leftrightarrow \perp [001] 10 5.4 x 6.4}***
EMT	EMC-2	[001] 12 7.4 x 7.6* \leftrightarrow \perp [001] 12 6.6 x 6.7**
FAU	Faujasite	$\langle 111 \rangle$ 12 7.4***
GME	Gmelinite	[001] 12 7.0* \leftrightarrow \perp [001] 8 3.6 x 3.9**
LTL	Linde Type L	[001] 12 7.1*
MAZ	Mazzite	[001] 12 7.4* 8 [001] 3.4 x 5.6*
MEI	ZSM-18	[001] 12 6.9* \leftrightarrow \perp [001] 7 3.2 x 3.5**
MOR	Mordenite	[001] 12 6.5 x 7.0* \leftrightarrow [010] 8 2.6 x 5.7*
MTW	ZSM-12	[010] 12 5.5 x 5.9*
OFF	Offretite	[001] 12 6.7* \leftrightarrow \perp [001] 8 3.6 x 4.9**
-RON	Roggianite	[001] 12 4.2*
VET	VPI-8	[001] 12 5.9*

Table 2 (continued)

10-Ring Structures

AEL	AlPO ₄ -11	[100] 10 3.9 x 6.3*
AFO	AlPO ₄ -41	[001] 10 4.3 x 7.0*
AHT	AlPO ₄ -H2	[001] 10 3.3 x 6.8*
DAC	Dachiardite	[010] 10 3.4 x 5.3* ↔ [001] 8 3.7 x 4.8*
EPI	Epistilbite	[100] 10 3.4 x 5.6* ↔ [001] 8 3.7 x 5.2*
EUO	EU-1	[100] 10 4.1 x 5.7* with large side pockets
FER	Ferrierite	[001] 10 4.2 x 5.4* ↔ [010] 8 3.5 x 4.8*
HEU	Heulandite	{[001] 10 3.0 x 7.6* + 8 3.3 x 4.6*} ↔ [100] 8 2.6 x 4.7*
LAU	Laumontite	[100] 10 4.0 x 5.3*
MEL	ZSM-11	<100> 10 5.3 x 5.4***
MFI	ZSM-5	{[010] 10 5.3 x 5.6 ↔ [100] 10 5.1 x 5.5}***
MFS	ZSM-57	[100] 10 5.1 x 5.4* ↔ [010] 8 3.3 x 4.8*
MTT	ZSM-23	[001] 10 4.5 x 5.2*
NES	NU-87	[100] 10 4.7 x 6.0**
-PAR	Partheite	[001] 10 3.5 x 6.9*
STI	Stilbite	[100] 10 4.9 x 6.1 ↔ [101] 8 2.7 x 5.6*
TON	Theta-1	[001] 10 4.4 x 5.5*
WEI	Weinebeneite	[001] 10 3.1 x 5.4* ↔ [100] 8 3.3 x 5.1*
-WEN	Wenkite	<100> 10 2.6 x 4.9** ↔ [001] 8 2.2 x 2.7*

9-Ring Structures

-CHI	Chiavennite	[001] 9 3.9 x 4.3*
LOV	Lovdarite	[010] 9 3.2 x 4.4* ↔ [001] 9 3.2 x 3.7* ↔ [100] 8 3.6 x 3.7*
RSN	RUB-17	[100] 9 3.3 x 4.4* ↔ [001] 9 3.1 x 4.3* ↔ [010] 8 3.4 x 4.1*
VSV	VPI-7	[011] 9 3.3 x 4.5* ↔ [01 $\bar{1}$] 9 3.3 x 4.5* ↔ [10 $\bar{1}$] 8 3.7 x 3.7*

8-Ring Structures

ABW	Li-A (Barrer and White)	[001] 8 3.4 x 3.8*
AEI	AlPO ₄ -18	[001] 8 ~3.8 x 3.8* ↔ ⊥ [001] 8 ~3.8 x 3.8**
AFT	AlPO ₄ -52	⊥ [001] 8 2.8 x 4.4***
AFX	SAPO-56	⊥ [001] 8 3.4 x 3.6***
APC	AlPO ₄ -C	[001] 8 3.4 x 3.7* ↔ [100] 8 2.9 x 5.7*

Table 2 (continued)

8-Ring Structures (continued)

APD	AlPO ₄ -D	[010] 8 2.1 x 6.3* ↔ [001] 8 1.3 x 5.8*
ATN	MAPO-39	[001] 8 4.0*
ATT	AlPO ₄ -12-TAMU	[100] 8 4.2 x 4.6* ↔ [010] 8 3.8 x 3.8*
ATV	AlPO ₄ -25	[001] 8 3.0 x 4.9*
AWW	AlPO ₄ -22	[001] 8 3.9*
BIK	Bikitaite	[001] 8 2.8 x 3.7*
BRE	Brewsterite	[100] 8 2.3 x 5.0* ↔ [001] 8 2.8 x 4.1*
CAS	Cesium Aluminosilicate (Araki)	[100] 8 4.7 x 2.2*
CHA	Chabazite	⊥ [001] 8 3.8 x 3.8***
DDR	Deca-dodecasil 3R	⊥ [001] 8 3.6 x 4.4**
EAB	TMA-E	⊥ [001] 8 3.7 x 5.1**
EDI	Edingtonite	[110] 8 2.8 x 3.8** ↔ [001] 8 variable*
ERI	Erionite	⊥ [001] 8 3.6 x 5.1***
GIS	Gismondine	{[100] 8 3.1 x 4.5 ↔ [010] 8 2.8 x 4.8}***
GOO	Goosecreekite	[100] 8 2.8 x 4.0* ↔ [010] 8 2.7 x 4.1* ↔ [001] 8 2.9 x 4.7*
JBW	NaJ (Barrer and White)	[100] 8 3.7 x 4.8*
KFI	ZK-5	<100> 8 3.9*** <100> 8 3.9***
LEV	Levyne	⊥ [001] 8 3.6 x 4.8**
LTA	Linde Type A	<100> 8 4.1***
MER	Merlinoite	[100] 8 3.1 x 3.5* ↔ [010] 8 2.7 x 3.6* ↔ [001]{ 8 3.4 x 5.1* + 8 3.3 x 3.3*}
MON	Montesommaite	[100] 8 3.2 x 4.4* ↔ [001] 8 3.6 x 3.6*
NAT	Natrolite	<100> 8 2.6 x 3.9** ↔ [001] 8 variable*
PAU	Paulingite	<100> 8 3.8*** <100> 8 3.8***
PHI	Phillipsite	[100] 8 3.6* ↔ [010] 8 3.0 x 4.3* ↔ [001] 8 3.2 x 3.3*
RHO	Rho	<100> 8 3.6*** <100> 8 3.6***
RTE	RUB-3	[001] 8 3.7 x 4.4*
RTH	RUB-13	[100] 8 3.8 x 4.1* ↔ [001] 8 2.5 x 5.6*
THO	Thomsonite	[101] 8 2.3 x 3.9* ↔ [010] 8 2.2 x 4.0* ↔ [001] 8 variable
VNI	VPI-9	⊥ [001]{<110> 8 3.5 x 4.0 ↔ [001] 8 3.5 x 3.5 }**
YUG	Yugawaralite	[100] 8 2.8 x 3.6* ↔ [001] 8 3.1 x 5.0*
ZON	ZAPO-M1	[100] 8 2.5 x 5.1* ↔ [010] 8 3.7 x 4.4*